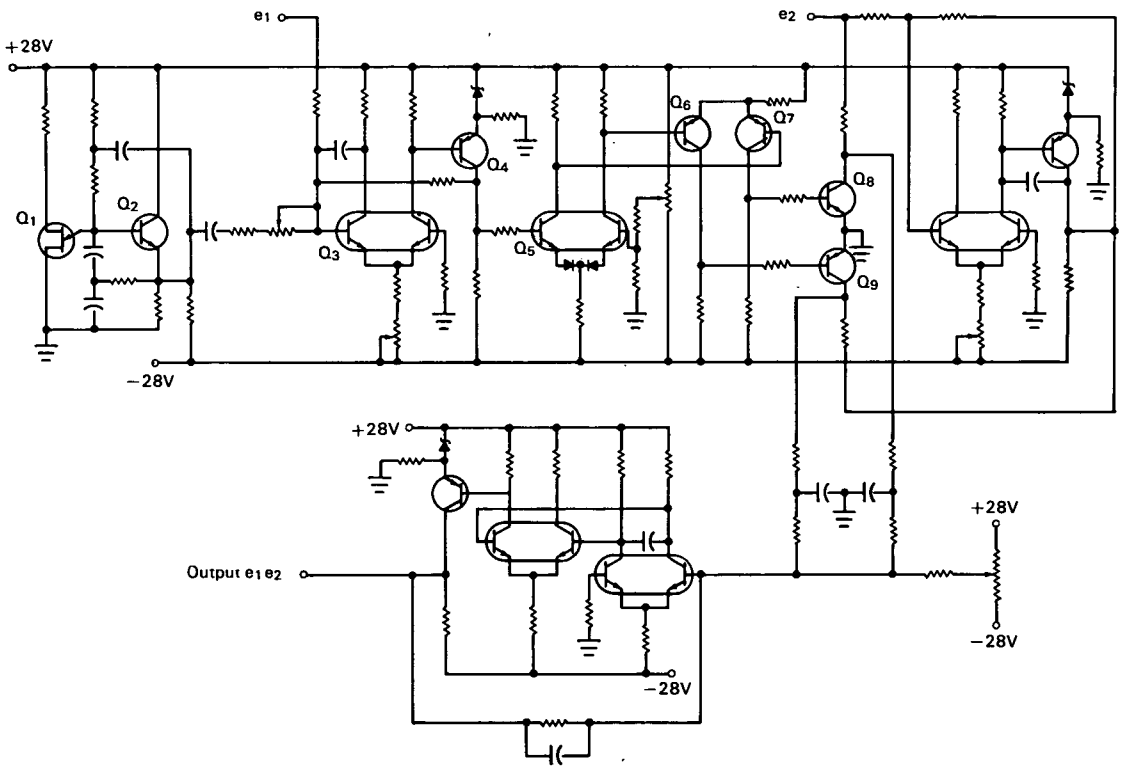
NASA TECH BRIEF

Circuit Provides Accurate Four-Quadrant Multiplication



The problem:

To design a circuit that will provide four-quadrant multiplication at frequencies ranging from dc to 100 cps. The circuit must consume little power and have an accuracy of approximately 1 percent.

The solution:

A solid state circuit using pulse-width and -height multiplication techniques.

How it's done:

The circuit uses ground referenced inputs and provides a ground referenced output. Transistors Q_1 and Q_2 generate a linear sawtooth waveform at a repetition rate of 3 kc. This sawtooth waveform is then fed into a closed-loop dc amplifier and summed with multiplier input e_1. The e_1 input is dc-coupled and the sawtooth waveform is ac-coupled to allow the sawtooth to be shifted at near ground level by the dc

(continued overleaf)

input. The output of the amplifier, obtained at the collector of Q_4, is dc-coupled into a high-gain switching amplifier which controls the multiplying switching transistors Q_8 and Q_9. The switching amplifier switches when the input-biased sawtooth waveform crosses zero.

The e_2 multiplier input is applied to the collector resistor of Q_8. This input is also inverted and applied to the collector resistor of Q_9. The output e_1e_2 of the multiplier is obtained by summing and filtering the output of the two switching transistors. When e_1 is zero, the sawtooth at the output of Q_4 is symmetrical about ground level and turns Q_8 and Q_9 on and off for equal time increments. Thus the output is zero regardless of the value of e_2. Similarly, when e_2 is zero, the output is zero for all values of e_1. When inputs e_1 and e_2 have any values other than zero, the switching duty cycles of Q_8 and Q_9 are changed in proportion to these inputs to provide an output equal to the product of e_1 and e_2.

Note:

Inquiries concerning this innovation may be directed to:

Technology Utilization Officer
Western Operations Office
150 Pico Boulevard
Santa Monica, California 90406
Reference: B66-10331

Patent status:

No patent action is contemplated by NASA.

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